

Growth, Sustainability, Security, and the Pace of Life in Cities

Luís M. A. Bettencourt, T-7

Humanity has just crossed an historic threshold with a majority of people worldwide now living in cities. Yet, even as the debate on how humans impact the natural environment heats up, urbanization and its consequences remain poorly understood. For many, cities are the principal sources of our social and environmental problems in terms of crime and social unrest, pollution, poverty, and, often, incidence of several diseases. But cities have also always been disproportionately the birthplaces for most of human prosperity, innovation, and culture.

A team of researchers have found the key [1,2] to understanding and quantifying these seemingly contradictory features of urbanization. They analyzed a large number of urban indicators in the U.S., China, and several European countries, covering measures of economic productivity, innovation, demographics, crime, public health, infrastructure, and patterns of human behavior. They discovered that all these quantities follow simple statistical scaling relations (see Fig. 1) with population, indicating a continuum of change from small cities to the largest megapolis.

These relations quantify how material infrastructures can show savings per capita as people live more densely. But most interesting is the behavior of social and economic quantities: measures of wealth creation and innovation, among others, increase per capita with city size, in such a way that doubling the size of a city increases its economic productivity per person by about 15%. This is seen worldwide from China, to Europe, to the U.S.

What is fascinating and surprising about these results is that they show that the good things about cities—such as their innovation, and the bad ones—such as crime and the incidence of certain diseases, increase predictably in the same proportion as cities become larger. There is a continuum in all these quantities that accelerates dynamics that are already there in the smallest towns, making them apparent and conspicuous in the largest cities. This unity of dynamics,

characterized by faster and faster rates per capita with larger urban populations, means that the pace of life increases measurably with city size, as we have all experienced: cities are social accelerators. Having seen this effect in aggregated quantities such as wages, patents, or crime rates, the researchers could also see it in patterns of individual human behavior; for example, on average, people actually do walk faster the larger the city [1].

What these results mean for the growth of cities is also a fascinating issue. If growth is driven by economies of scale via exploitation of efficiencies, the city will ultimately stop growing. This has been known to economists for some time. But if instead, increasing returns to scale in innovation and wealth drive population growth, then a city will grow at an accelerated pace, faster than exponentially, and will eventually be driven to a crisis. To avoid this, cities must generate major adaptations that effectively restart these dynamics and begin a new growth cycle. The analysis also shows that the duration of such cycles decreases with population size. These patterns of accelerating, punctuated growth are observed for the historic population growth of New York City (see Fig. 1) and may be a feature of other social organizations.

These results will change the way people think of cities and project their growth. Although many of today's megacities present some of most daunting problems in terms of poverty, crime, and overtaxed infrastructure, these problems can be overcome by the ingenuity and resources that are already present in these places, as has happened historically in now-developed countries.

For further information contact Luís M. A. Bettencourt at lbett@lanl.gov.

[1] L.M.A. Bettencourt et al., *PNAS (USA)*, **104**, 7301-7306 (2007).

[2] L.M.A. Bettencourt et al., *Research Policy*, **36**, 107-120 (2007).

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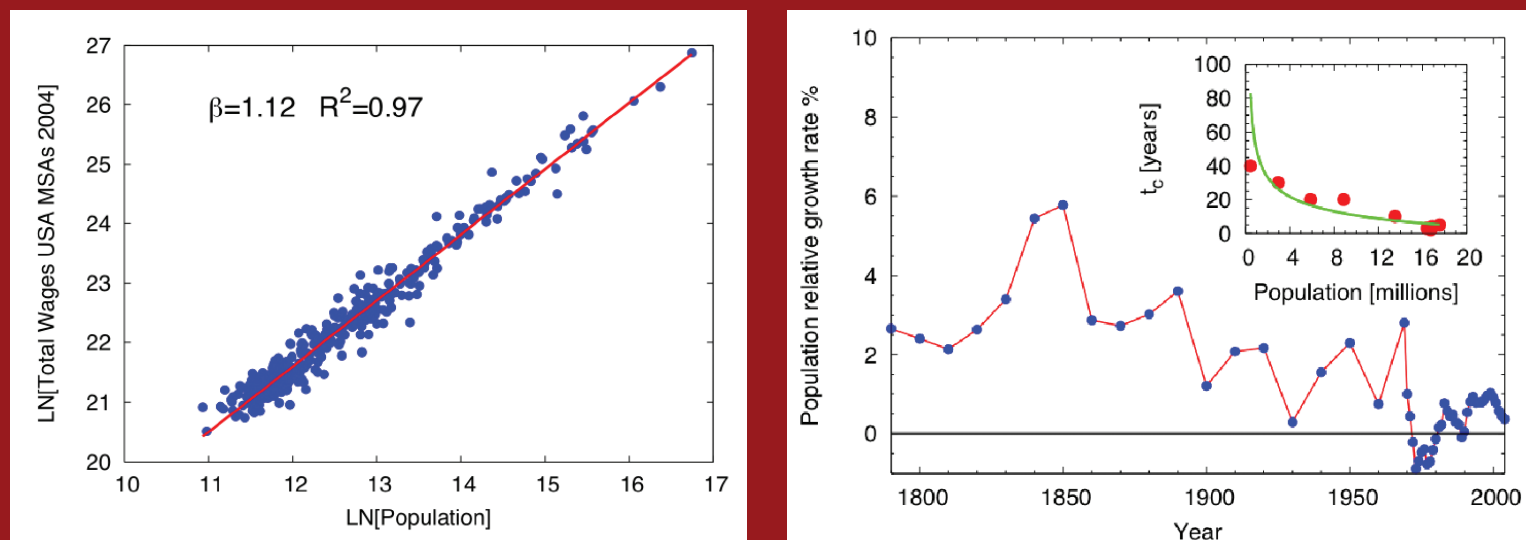


Fig. 1. (Left) Increasing returns to scale in total wages for American Metropolitan Statistical Areas (MSA). Wages obey a scaling relation with exponent $b=1.12>1$, implying an increasing rate of wealth production as cities get larger. (Right) The population of New York City MSA has grown following shortening cycles of super-exponential growth. Inset shows the city's population growth as growth cycles shorten.